The Music of the Sphere: An Investigation into Asymptotic Harmonics, Brainwave Entrainment and the Earth as a Giant Bell

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ABSTRACT

The author discusses a conceptual framework for the organization and performance of music that has its basis in the frequency relationships of the Schumann Resonances and in the principle of binaural beats. He describes the steps he took in conceiving the project, the technical issues involved in realizing the goal of live data transmissions from a remote location and the creation of the three-dimensional overtone series that is the project's theoretical centerpiece. He also lays out his philosophy of improvisation and treads lightly into the curious gray areas where science mutates into leaps of faith.

INITIALIZATION

In the spring of 2002 I was invited by Voorkamer Gallery in Lier, Belgium [1], to create a sound installation as part of an exhibition entitled Mapping the Vicinity. The participants in the show were requested to create a work related to the idea of mapping—the charting, naming and claiming of territory. Mulling over various possibilities, I decided to research the area of brainwave states—a somewhat loosely defined but commonly agreed upon division of the levels of human consciousness into four frequency ranges of activity as measured by an electroencephalograph (EEG) (Fig. 1): (1) delta, 3 Hz and below (generally associated with deep sleep); (2) theta, 4–7 Hz (light sleep or dreaming); (3) alpha, 7–13 Hz (relaxed consciousness—sometimes referred to as a meditative state); and (4) beta, 13 Hz and above (active, "walking around" consciousness).

Not at all sure where this subject would lead me, I plunged ahead, reading everything I could find on the subject. In the midst of my trolling for potentially relevant information, I happened upon the concept of binaural beats. Binaural beats can be briefly described as auditory responses originating in each hemisphere of the brain that are caused by the interaction between two slightly detuned sine waves, divided between the left and right ears. When experienced through headphones, the interaction of these signals is perceived directly within the brain as a pulse equal to the difference between the two original frequencies. For example, receiving a 440-Hz signal in the left ear and one of 447 Hz in the right results in a 7-Hz pulse or beating tone.

According to clinical studies, if one listens long enough, one's brainwave activity will enter into a sympathetic resonance with this pulsing and, for example, in the instance stated above, the subject will begin to settle into an alpha state. This technique has been shown to be useful as a tool for consciousness management in such areas as stress reduction, pain control and the improvement of concentration and information retention [2]. Some proponents of the treatment also believe that binaural beat brainwave entrainment (as it is most often called—hereafter BBBE) may facilitate the actualization of more esoteric practices such as astral projection, telepathy and lucid dreaming—the ability to control the direction of one's thoughts while sleeping [3].
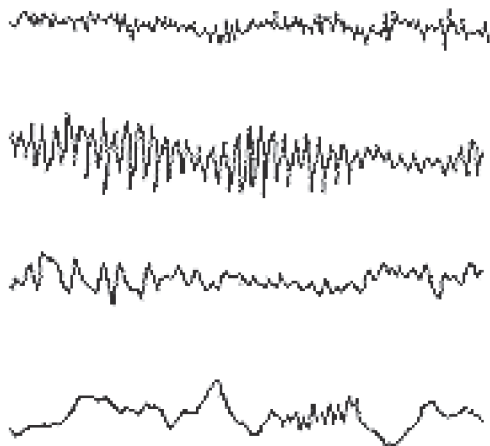
Whether or not I was prepared to accept the headier claims regarding BBBE, the technique itself was an interesting find since it is closely related to certain cornerstone musical procedures of mine. For many years now, I have been involved, both as a composer and as an improviser, with the dynamic creation and resolution of beating tones—in what I have referred to as the dance of gravity between 12-tone equal temperament and just-intonation tuning systems. Being a strong believer in serendipity, I decided to mine this new vein and place my longstanding infatuation with the beating tone phenomenon under even closer scrutiny. The difference was that what had been, until now, done in the name of sensuality and artistic sensibility would now take on a deeper purpose. I wanted to mess with people's minds.

I began to develop ideas for my sound installation. It would be a "sonic restaurant" called *Dave's Waves*—an establishment where the customer would sit at a table equipped with a CD player with headphones and order from a menu of sound-

Fig. 1. The four brainwave states as measured by an electroencephalograph (from top to bottom): beta, alpha, theta, delta.

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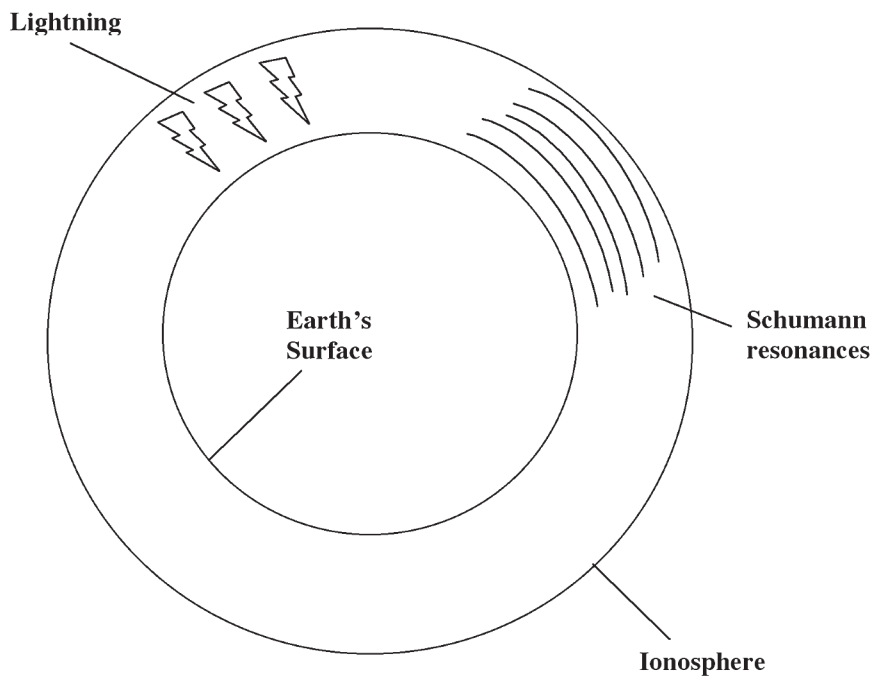
Fig. 2. The Earth's ionosphere cavity. (© David First)

scientist W.O. Schumann in 1952 and officially detected by him 2 years later, they have since been measured through increasingly sophisticated means [6]. By the 1980s, computer technology had advanced to the point where it became possible to record and analyze variations in the amplitudes and frequencies of the Schumann Resonances in real time [7].

Where views start to diverge is in the area of what it all means—what these numbers represent and what they portend for the future. There appears to be a great deal of mistrust between two camps—the (largely) university-based scientists and, for lack of a better term, the new-agers. At the universities, the data is used to track global weather patterns. Lightning is associated with active thunderstorm systems, which, in turn, are driven by thermal anomalies in the Earth's atmosphere. It is thought that by studying the Schumann Resonances—and their source, global lightning—it may be possible to gain insight into global warming through its effects on thunderstorm formation. From the other side, there are many rumors floating around the Internet about the Schumann Resonance frequencies having risen radically in recent years and this, in turn, being an indication of the world's imminent demise—or, at least, some sort of major paradigm shift [8]. The end may indeed be coming, but all actual recorded data that I have come across clearly show that the Schumann Resonances have been fairly stable for as long as they have been measured and could not possibly change by very much unless two important factors in these measure-

scapes designed to induce specific states of consciousness. This was to be a personal experience—besides the sound from the headphones, there would be complete silence in the room itself. I started sketching out some ideas in Csound, the audio synthesis program I had been using for all my precision tuning needs [4]. Then one day, while checking out Internet sites concerned with BBBE, I found a link to something called the Schumann Resonances [5].

HUM OF THE EARTH

As I started my new line of inquiry, I reminded myself that, just as in binary beat research, slippery slopes are everywhere. There is much information to be found in the realm of "hard science," but there is even more material that expounds more fantastical lines of thought—an area that I have come to think of as "outsider" science. The World Wide Web's democratization of all stances is, for me, a large part of its charm, and I found that mulling over some of the more colorful notions can be oddly inspirational. As an artist, I long ago came to the conclusion that I am caught in the middle between the "godless" rational scientists and the "god-infatuated" superstitionists who find profound and intimate extraterrestrial connections and conspiracies everywhere. One of my personal definitions of an artist is someone who draws upon the unexplainable but who does not wish to share the credit. Suffice it to say, I find numbers to be quite magical—and the

belief in a consciousness beyond this earthly one, for the most part, quite reasonable.

Regarding the Schumann Resonances, everyone seems to agree on the basics. The Schumann Resonances denote a phenomenon that occurs in the Earth's ionospheric cavity (Fig. 2) as a result of continual lightning discharges striking the Earth. This ongoing agitation causes the Earth to ring as if it were a giant bell, resulting in a set of quasi-standing waves that measure between approximately 8 Hz and 45 Hz (± a 0.5-Hz diurnal deviation). Initially hypothesized by German

Fig. 3. Tables in the sonic restaurant *Dave's Waves*, 2002. (Photo © Paul Verstreken)

ments—the Earth's size and/or the speed of light—were also to change. Neither change is very likely.

There is, however, one area of fascination for some in the new-age camp that seems worthy of serious study. This is the apparent fact that much of the human brain's electrical activity is in the same range of frequencies as the Schumann Resonances and that the alpha state, in particular, lines up quite nicely with the lowest—or fundamental—Schumann frequency. It may not be completely unsound to posit a correlation between the two.

Such a correlation also seems, to me, to provide a fertile ground for musical exploration. Working on the *Dave's Waves* sound installation for the Lier exhibition, I created "dishes" for my sonic restaurant made up of both sets of numbers (Fig. 3). The menu offered four different 20-minute soundscapes composed of the average frequencies (according to the consensus in all the literature I found) of the first seven Schumann Resonances transposed into the audio range and modulated by emulations of the four brainwave frequency ranges [9]. The positive audience reaction to *Dave's Waves*—which was set up in an actual unoccupied restaurant in the center of town—was both encouraging and inspiring. It was fun to observe users' initially confused responses to the idea and then watch them become immersed in the experience. The process also appeared to have a strong effect on those who spent more than a cursory amount of time under the headphones. But this was merely the beginning.

DIRECT CONNECTIONS

There was one name that kept popping up in much of the Schumann Resonance information I found—Davis Sentman. Whether in a link or a quote or a footnote, he certainly seemed to be in the thick of things. I decided I had to find out more about Sentman, since he appeared to be one of the leading authorities—if not *the* leading authority—on the Schumann Resonances. Sentman, of the geophysics department at the University of Alaska, Fairbanks, had one of the most interesting and extensive of the "earthbound" web sites I had found on the subject—with many clear explanations and charts. He also had an e-mail address posted for receiving questions and comments [10].

Upon returning from Lier, I decided to take Sentman up on his offer and sent him an e-mail explaining what I had been

up to and requesting help with certain concerns and confusions. He was quick to respond and in a couple of e-mail exchanges he very graciously gave me more information than I could have ever hoped for. During this time, however, a fantasy had begun developing in my mind of transposing Schumann Resonance data in real time from a live feed. For as much as I was intrigued and inspired by the sounds resulting from the numbers I had discovered, I felt that tuning in to the current state of the Earth's resonance—or coming as close to that ideal frequency as could be achieved—held the seeds of a potentially transformative experience well beyond the abstraction represented by modeling these numbers or even using actual data collected from an earlier period. I wanted to tap into and jam (dare I say communicate?) with a living, breathing phenomenon rather than settle for a sort of time-displaced karaoke. I proceeded to put forth my fantasy to Sentman. I then asked if there were any methods for transmitting over the Internet the Schumann Resonance data that he and a handful of other scientists were collecting at various remote outposts around the world.

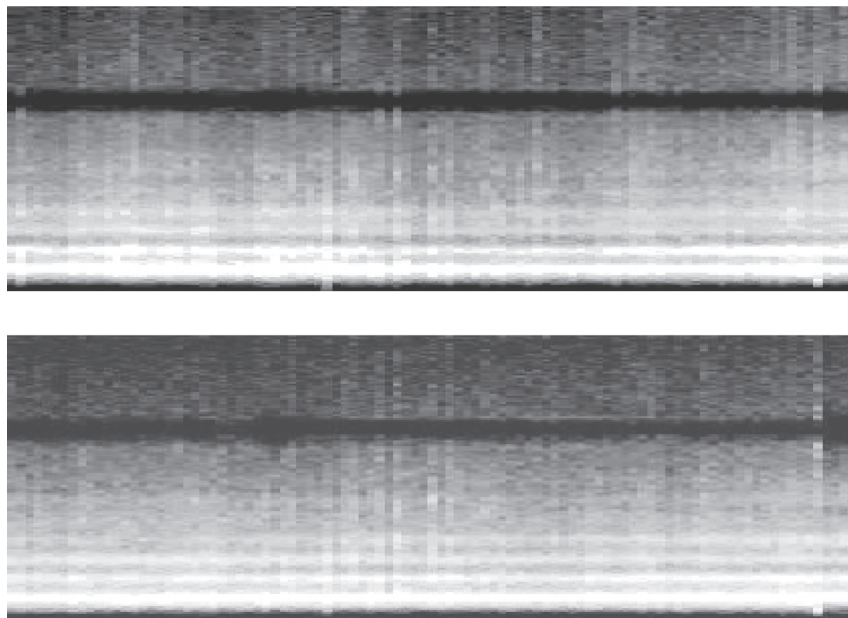I got an answer from Sentman the very next day stating that in response to my request, he had written an application that would allow me to receive said information. Needless to say, I was thrilled, but this solved only part of the puzzle—I still needed to have something working on *my* side. I had slowly been migrating from Csound to Cycling '74's Max/MSP [11] audio synthesis software over the previous few months, specifically for this project because of its live performance strengths. My plan was now to use Max/MSP to transform the real-time data feed into various species of sonic material, and I asked my friend and fellow musician, Dafna Naphtali, to help implement the connection to Alaska.

To start us off, Sentman sent us a data example formatted as an ASCII string:

Schumann spectral values at Poker Flat, Alaska, as of 10/12/2002, 10:25:21 PM: 8.100 11.109 13.973 3.275 21.003 1.593 25.760 1.528 32.159 0.829 37.526 0.713

In this example, the numbers following the time are the peak frequencies and associated amplitudes, e.g. 8.100 11.109, where 8.100 is the frequency in Hz and the amplitude is 11.109, etc. The amplitude is, in this case, relative and would have to be scaled according to whatever equipment I planned to feed it to (Fig. 4). This information would be updated every 5 seconds. He also warned me to be on the alert for any quick bursts of numbers completely out of range—apparently it was not unusual, given the lo-

Fig. 4. Two sample spectrograms showing typical spectra for the x and y axes of the Poker Flat, Alaska, extremely low frequency (ELF) system. The vertical axis is frequency 0 to ~90 Hz. The horizontal axis is time, covering about 8 hours. The color axis is power, running from black (zero) through purple, red, yellow and white (maximum). The Schumann Resonances show up as the horizontal banded structures. The brightest line near the bottom is the ~7.8-Hz fundamental mode, the next one up is the 14-Hz line, etc. The dark horizontal band running across the plot is the 60-Hz notch filter needed to suppress power line noise. (© David First)

cation, for a moose to trip over the cables connected to his sensors (Fig. 5) and send things temporarily haywire!

We began modifying my Max patch (Fig. 6), integrating into it objects coded specifically for Internet connectivity [12]. Through a series of hours-long three-way conference calls between Naphtali in Brooklyn, me in Manhattan and Sentman in Fairbanks (and despite one major earthquake in Alaska that knocked out all communication for a couple of crucial days before what was to be the premiere performance) we solved some nagging formatting issues between Sentman's Windows system and my Mac-based Max/MSP application and succeeded in setting up the situation I had fantasized about. Since I had been modeling these frequencies for a while, the resulting sound was, in itself, no major surprise. But perhaps because of that, the first time I saw and heard the live data feed coming into my Max patch and coming out my speakers was pretty close to a religious experience. Something that I had accepted on faith really did, in fact, exist.

WHERE I WENT WRONG

In both the Lier installation and the premiere presentation in New York at the performance space Roulette for what I was now calling *Operation:Kracpot,* my primary method for audification of the Schumann Resonances was to multiply data that was coming in (or in the case of the Lier installation, the data that I was modeling) by a factor of 16, thereby placing the relatively low set of original frequencies into a reasonable musical range—a four-octave transposition. This result was, indeed, a quite beautiful-sounding set of harmonic relationships unlike anything I had previously heard—a transparent, bell-like chordal hum. But then a realization set in—this multiplication was a complete distortion of the true situation. If the Schumann Resonances are the harmonics of the Earth—which is spherical—then they do not follow the same simple geometric series of integers as do the harmonics of a string. The proportions are much more complex. In order to stay true to this ideal, the theoretical upper partials I was looking for had to have relationships that somehow continued on the same trajectory as the observable ones. Or, to interpolate the ancient alchemist's creed, "as below, so above."

Early in our correspondence, Sentman had shown me an analytical formula that described the harmonic resonances of a spherical cavity resonator, noting that the Schumann Resonances hewed very closely to these numbers:
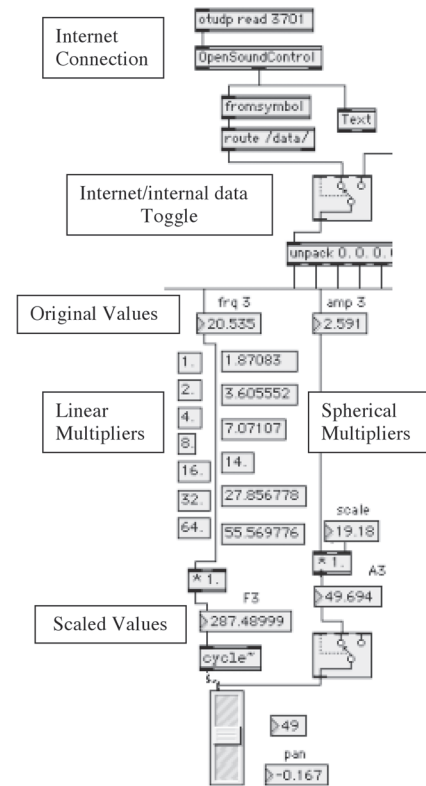

Fig. 6. Detail of live feed section of Max/MSP patch featuring one of the six oscillators. (© Davis D. Sentman)
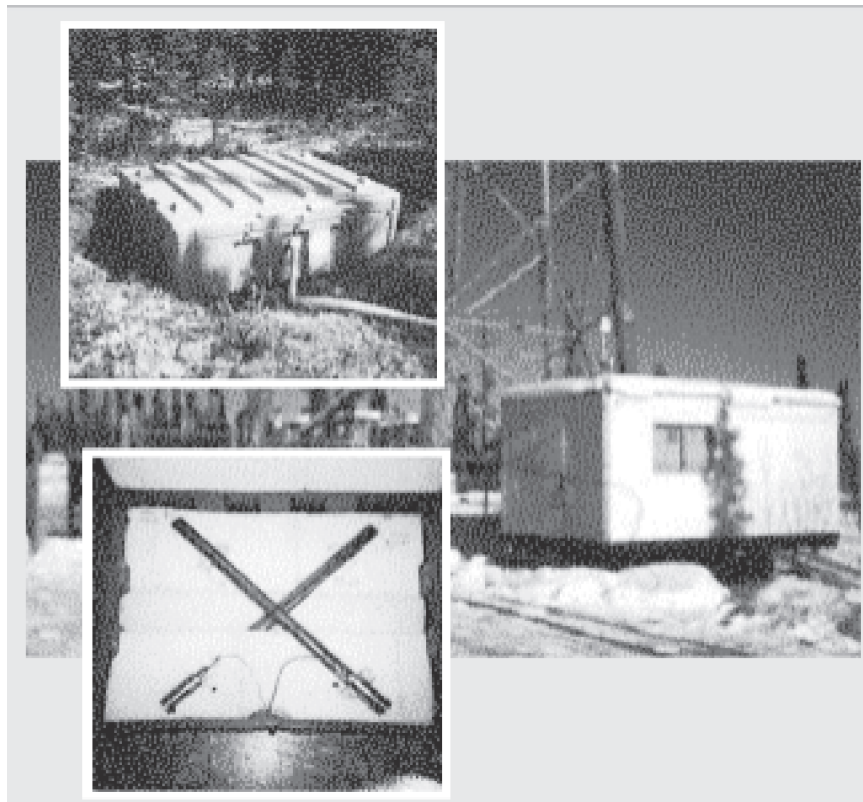
$$f(n) = f0*sqrt(n*(n+1))$$

where $f(n)$ = frequency of the nth resonance, $n = 1, 2, 3, \ldots$, and $f0$ is a constant that depends on factors such as the physical dimension of the system, the speed of light, etc. For a cavity the size of the Earth, $f0 = 5.5366$.

At the time I thought that this was fairly interesting, but now it was becoming clear that the ramifications of this formula went far deeper. I realized that in order to find the higher resonant frequencies that would both "harmonize" with the Earth and also be comfortably in the audio range, I needed to implement this formula instead of doing the traditional overtone math. An octave was no longer an octave.

DOWN THE RABBIT HOLE

I began to plug higher and higher numbers into the formula until I had created a continuum of values that gave me a reasonable expanse within which to work compositionally (Fig. 7). It soon became clear that the "octaves"—the distances between the 1st, 2nd, 4th and 8th harmonics, the 8th and 16th, the 16th and 32nd, etc.—which were increasing by less than twice the frequency of the previous,

Fig. 5. Sensor box, x/y sensors and instrument trailer at the Geophysical Institute's Gokona, Alaska, ELF site. (© Davis D. Sentman)

Harmonic	Frequency in Hz
1	7.829934809434878
2	13.56184490989334
3	19.17934500237169
4	24.76042792845067
5	30.32520711883103
6	35.88126895080496
7	41.43212057522521
2	13.56184490989334
4	24.76042792845067
6	35.88126895080496
8	46.97960885660927
10	58.06835068778861
12	69.15211183586514
14	80.23295649295245
4	24.76042792845067
8	46.97960885660927
12	69.15211183586514
16	91.31194642717896
20	113.4665352216238
24	135.6184490989334
28	157.7688147978554
8	46.97960885660927
16	91.31194642717896
24	135.6184490989334
32	179.9182041244298
40	224.2152110772148
48	268.5108300332037
56	312.805650645125

Harmonic	Frequency in Hz
16	91.31194642717896
32	179.9182041244298
48	268.5108300332037
64	357.099969993838
80	445.6877027121121
96	534.2747281902074
112	622.8613481918428
32	179.9182041244298
64	357.099969993838
96	534.2747281902074
128	711.4477141819489
160	888.6199879957686
192	1,065.791904799131
224	1,242.963617256756
64	357.099969993838
128	711.4477141819489
192	1,065.791904799131
256	1,420.135201849289
320	1,774.478140638312
384	2,128.820900064259
448	2,483.163556911449
128	711.4477141819489
256	1,420.135201849289
384	2,128.820900064259
512	2,837.506149609435
640	3,546.191219476806
768	4,254.876199446879
896	4,963.561128025595

Fig. 7. The first seven spherical harmonics and their higher octaves, where f(n) = 5.5366*sqrt(n*(n+1)). (© David First)

were moving ever towards that quantitative relationship with each interval. It was as if someone had left the overtone series out in the rain, and it had warped. I started finding startling hidden relationships—the 8th harmonic was exactly 6 times the frequency of the fundamental rather than the usual 8-to-1 relationship. This would be called a 3/2 in what I was beginning to think of as the *linear* overtone series (as opposed to what I was now calling the *spherical* overtone series)—arguably the most important interval in traditional music since it is the creative basis of the scale system in both just intonation and 12-equal temperament (where it is referred to as a perfect 5th). Then I discovered that the 24th and the 2nd were in a 10-to-1 ratio—or 5/4 in just intonation—and that the ratio of the 48th and the 3rd was 14 to 1—or 7/4 in just intonation. There was an emerging pattern revealing all the linear overtone series relationships embedded within the spherical one (Fig. 8). They simply were not following a simple line—they were following an ever-widening curve. Other interesting relationships also revealed themselves—the ratio between the 3rd harmonic and the 2nd was exactly the square root of 2. That of the 4th to the 1st was the square root of 10.

Now, I am a composer, not a mathematician or a physicist, so I was not sure if what I was discovering would be obvious to someone in either of these disciplines. But when I ran my findings by Sentman, he seemed as intrigued as I was. What I had uncovered was an overtone series that was completely analogous to the beating-tone phenomenon with which I was so enamored. It begins "out of tune" and rises to a theoretical perfect resolution—albeit one significantly above our range of hearing (Fig. 9). But what a beautiful construction to wax poetic about—our imperfect earthly existence reaching perfection somewhere in the heavens. And neither Sentman nor I were beyond conjecturing that the *whole thing* might be "in tune" in another (higher?) dimension—or to another species in this one. It was giddying stuff.

I began reconfiguring my Max/MSP patch so that the spherical cavity formula was now part of the inner workings of any harmonic movement that I wished to make. Thus I could also model any section of the series in order to output it along with, or have it modulated by, the information coming in. I then used the formula to create a complex waveform that I began calling the *asymptotic sawtooth wave*, as it retained the same partial-to-partial relationship one would find in the traditional sawtooth wave (Fig. 10). I also did the same for the waveforms' amplitudes by inverting the resulting ratios. My plan was to use the untransposed, sub-audio range of incoming data and/or spherical harmonic models as modulating sources for tremolo, vibrato, dynamic panning, etc. This would allow me to continue to experiment with the frequency range of brainwave pulsations associated with BBBE while also adding, when desired, a rhythmic dimension to the music. Here were the beginnings of a wholly new sonic palette with which to work. All that remained to do was to throw away much that I held dear.

REFLECTED LIGHT

Working with the elements I objectify in *Operation:Kracpot* has delighted and inspired me like nothing else I have been

Fig. 8. The first 16 just intonation relationships in the spherical overtone series, where f(n) = 5.5366*sqrt(n*(n+1)). (© David First)

Harm ratio	Numerator in Hz	Denominator in Hz	Quotient	Reduction
1/1	7.829934809434878	7.829934809434878	1	1/1
8/1	46.97960885660927	7.829934809434878	6	3/2
24/2	135.6184490989334	13.56184490989334	10	5/4
48/3	268.5108300332037	19.17934500237169	14	7/4
80/4	445.6877027121121	24.76042792845067	18	9/8
120/5	667.1545566142826	30.32520711883103	22	11/8
168/6	932.9129927209289	35.88126895080496	26	13/8
224/7	1,242.963617256756	41.43212057522521	30	15/8
288/8	1,597.306701124715	46.97960885660927	34	17/16
360/9	1,995.94238023486	52.52479947986475	38	19/16
440/10	2,438.870728887122	58.06835068778861	42	21/16
528/11	2,926.091790491665	63.6106910976449	46	23/16
624/12	3,457.605591793257	69.15211183586514	50	25/16
728/13	4,033.412149999888	74.69281759259052	54	27/16
840/14	4,653.511476591242	80.23295649295245	58	29/16
960/15	5,317.903579463772	85.77263837844794	62	31/16

Oct ratio	Numerator in Hz	Denominator in Hz	Quotient
2/1	13.56184490989334	7.829934809434878	1.732050807568877
4/2	24.76042792845067	13.56184490989334	1.825741858350554
8/4	46.97960885660927	24.76042792845067	1.897366596101028
16/8	91.31194642717896	46.97960885660927	1.9436506316151
32/16	179.9182041244298	91.31194642717896	1.970368732287556
64/32	357.099969993838	179.9182041244298	1.984790653795493
128/64	711.4477141819489	357.099969993838	1.992292842237498
256/128	1,420.135201849289	711.4477141819489	1.996120267927514
512/256	2,837.506149609435	1,420.135201849289	1.998053527519392
1024/512	5,672.246024475314	2,837.506149609435	1.99902510352482
2048/1024	11,341.72476215523	5,672.246024475314	1.999512135619038
4096/2048	22,680.681731057	11,341.72476215523	1.999755963637674
8192/4096	45,358.59541552334	22,680.681731057	1.999877955758849
16384/8192	90,714.42265776038	45,358.59541552334	1.999938971362298
32768/16384	181,426.0770788799	90,714.42265776038	1.999969484051601
$(2^{16})/(2^{15})$	362,849.3858894399	181,426.0770788799	1.99998474161838
$(2^{17})/(2^{16})$	725,696.0034947199	362,849.3858894399	1.999992370707331
$(2^{32})/(2^{31})$	23,779,515,933.8019	11,889,757,968.2851	1.999999999767169
$(2^{33})/(2^{32})$	47,559,031,864.8355	23,779,515,933.8019	1.999999999883585
$(2^{48})/(2^{47})$	1,558,414,356,056,221	779,207,178,028,111.8	1.999999999999996
$(2^{49})/(2^{48})$	311,682,8712,112,439	1,558,414,356,056,221	1.999999999999998

Fig. 9. Selected spherical octaves relationship chart. (© David First)

involved with in many years. But it has also resulted in my having developed a slight case of professional disorientation. As a composer, I have had to surrender a large amount of my organizational predilections in order to enter into and understand this collaboration with the "unknowable." And I suppose since, in this case, the partnership is so blatant, I could hardly avoid finally sharing the credit—if not some responsibility—for whatever happens. The Schumann Resonances are what they are. They are never going to dance nicely through my favorite chord progressions. Nor are they ever likely to resolve into the columns of precise and neat whole-number ratios I have enjoyed in just intonation. Nor am I interested in developing ways of shoehorning them into such contrivances. I have decided to meet and work with them—as much as possible, for now—on their terms.

On the other hand, I do know that it is not my goal to merely create a science-fair demonstration. Although the concern here is to expose and amplify the hidden forces at play all around us (and inside us), this is still, ultimately, an attempt to complement, enhance and even subvert nature—not merely present it "as is." This is human nature—or, at least, the artist's. So the challenge has been to establish a vocabulary of ideas that will allow me to consider this project worthy of public display in the category loosely defined as "musical performance."

This causes a bit of a dilemma, because there is something about the nature of (and in) this project that, for me, seems to be antithetical to presupposition and pretension. I am not so sure that I want to immediately begin civilizing this strange and beautiful new world with burdensome constructions and rules. And although the Schumann Resonances are, statistically, relatively predictable, they are still impossible to nail down completely—one never knows when a pitch or volume level will shift (especially in the case of the "moose scenario," which makes an excellent program-note caveat should anything go awry in performance). Therefore, the approach I have taken is to skate the line between fixed compositional roles on the one side and freely improvised communication and expression on the other, and, when in doubt, to err on the side of the latter.

This would not be quite as much an issue if my plans were to limit the human involvement to myself. I *am*, however, interested in slowly attempting to populate this new world. Until now, none of the musicians I have invited to participate in the initial performances of *Operation:Kracpot* has been reading from a score. But this does not mean that anything goes. Their preparation consists of, in part, a vast array of experiences in many contemporary, historical and world music practices and, perhaps most importantly, an acquaintance with my concepts of music making from performing my earlier, mere predetermined compositions. This includes a familiarity with an approach I call *gestural improvisation* [13].

It is also a "plus" that they do not cringe if I happen to use the word "ritual." I have always been envious of cultures that have kept the thread of an oral tradition for generation upon generation. I may, in fact, at some point bring out the paper and the stopwatches. For the time being, however, I am placing significant value on evolution in this project, and I have great hopes for keeping a core of these people together for as long

Fig. 10. The first 16 partials of an asymptotic sawtooth wave, where f(n) = f0*sqrt(n*(n+1)). (© David First)

n=	Frequency Relationships	Amplitude Relationships
1	1.0	1.0
2	1.732050807568877	.5773502691896259
3	2.449489742783178	.4082482904638631
4	3.162277660168379	.3162277660168379
5	3.872983346207417	.2581988897471611
6	4.58257569495584	.218217890235992
7	5.291502622129182	.1889822365046136
8	6.0	.1666666666666667
9	6.70820393249937	.149071198499986
10	7.416198487095663	.1348399724926484
11	8.124038404635961	.1230914909793327
12	8.831760866327847	.1132277034144596
13	9.539392014169456	.1048284836721918
14	10.2469507659596	.0975900072948533
15	10.95445115010332	.0912870929175277
16	11.6619037896906	.08574929257125442

as possible to see how far we can go in developing some traditions all our own.

There are those who have wondered whether real-time data transmission effects a profound change in the resulting sonic gestalt. The best reply I can give is: most probably yes. I have performed this work with a live feed a few times now and have rehearsed it and made recordings with stored data. Both have allowed for satisfying experiences of a sort. So it may be merely a type of existential conceit, more superstition or even a show-biz gimmick that has me continuing to go for the hook-up.

Or perhaps it is simply the fragile, believable magic of an Internet relationship—a continent away from an exotic locale—with a computer system and a marvelous person whom I have only met through phone lines. No doubt that is part of it. I cannot, or will not, dismiss any of these possibilities. I am a performer after all. But beyond that, I will continue to take advantage of this rare opportunity to harmonize in real time with the world's largest resonating cavity—a.k.a. the world—because I think it is also reasonably likely that there is a level of vibrational activity and connectivity that may not be so simply or quickly quantifiable by our limited technology and underdeveloped senses.

I also believe that belief, in and of itself, elicits change. Whether or not the alchemists were able to transform physical matter, the quest gave their life a purpose and an intensity that I feel is invaluable and irreplaceable. I am here (along with everyone else) riding a giant bell. A situation has revealed itself to me in which I could attempt to swing with it and even playfully decline its advances should I so desire. Learning to do this dance could—and probably should—take a lifetime. A fool's endeavor? As the Magic Eight Ball famously says, "Ask again later."

References and Notes

1. Voorkamer vzw, Bril 14, 2500 Lier, Belgium. The exhibition, held from 18 May to 15 June 2002, was curated by Patricia Smith and Thomas Broadbent.

2. Dale S. Foster, "EEG and Subjective Correlates of Alpha-Frequency Binaural-Beat Stimulation Combined with Alpha Biofeedback" (Memphis State University, May 1990) <http://www.calmcentre.com/sounds/mind/fosterstudy.html>.

3. The Monroe Institute, "Hemi-Sync Technology" <http://www.hemi-sync.com/main.html>.

4. Csound was developed by Barry L. Vercoe of the Massachusetts Institute of Technology <http://www.csound.org>.

5. Stan Heckman, "Schumann Resonances" <http://stanheckman.com/cgi-sys/cgiwrap/heckman/LightningWiki?browse=SchumannResonances>.

6. There is much speculation as to whether legendary Serbian scientist and inventor Nikola Tesla was aware of the resonances many years prior to Schumann. Indeed, Tesla apparently had great plans to power the world through the electromagnetic waves within the Earth. But he did not always communicate his ideas clearly. Nor did he have knowledge of the existence of the ionosphere, which had yet to be discovered. Though undeniably one of the great thinkers of his day, Tesla often chose to publish his findings in popular magazines rather than in the scientific journals of his time. Schumann, on the other hand, worked within the more accepted and traditional scientific channels and communicated the results of his work in the standard language of electromagnetic theory, thus creating a usable theory of these resonances.

7. Stanford University, "Index of Schumann Data Raw Spectra from West Greenwich, North America—Refined/Uncompressed" <http://schedar.com>.

8. Zero Point and the Schumann Resonances <http://www.2012.com.au/SchumannResonance.html>.

9. *Dave's Waves,* CD09 on the Italian label ants, including the works *Cross-Eyed Luck, Closet Earth, Queen Siesta* and *Harebrainer* (2003).

10. Sentman's web site is, unfortunately, down at the time of this writing and may remain so permanently, but from 1996 until November 2002 it resided at <http://sprite.gi.alaska.edu/schuchar.htm>.

11. Max/MSP was written by Miller Puckette and David Zicarrelli, with M. Lee, J. Clayton, R. Dudas, A. Schabtach, P. Rice and jhno.

12. Open Sound Control (OSC) and otudp are Max/MSP externals created by Matt Wright of Center for New Music and Audio Technologies (CNMAT) at the University of California at Berkeley <http://cnmat.cnmat.berkeley.edu>.

13. I define my concept of gestural improvisation as a set of procedures that isolates those musical elements traditionally considered ornamentation or aspects of expression and elevates them to the level of most significant extrapolative detail. Examples of fundamental gestural improvisation techniques would be the implementation of glissando/pitch bend/vibrato in the area of frequency, active filtering/overtone isolation in the area of timbre, and tempo modulation/syncopation/rubato in the area of rhythm. This detail, however, is only one set of coordinates in a field of continuous energy. It is a sim-

ple function that results in a multiplicative reaction—like the ripples caused by tossing pebbles into a pond. The improviser chooses (or, often, is assigned) a promising area—a pitch, a rhythm, a texture—to light upon and attempts to establish a sphere of transformative influence over the entire system. Gestural improvisation can also be practiced by making minute rates of change in any number of processing techniques, such as delay lines, panning, phase, etc. It breaks down singularities into microscopic scales and shadings in order to find deeper singularities—a single half-step frequency range or pulse rate may comprise the entire exploratory material for minutes at a time. The player sweeps through a particular circumscribed region with the intention of discovering a unique sonic dimension—an electrical, mesmerizing charge—that is the direct product of an acoustical fusion between his/her gesture and the surrounding energy field. Once this area has been identified and its epicenter determined, the player then develops a range of misalignment values that are used to create structures of tension and release. Gestural improvisation is, above all, an exercise in friction—one rubs in the same area with the same motion until the heat produces sparks. The resulting sound of this activity, in the best of circumstances, takes on a sort of illusory depth as the two axes (player and field) beget an ultra-vivid third entity not unlike moiré patterns that trick the eye—a type of sonic op art.

Discography: Solo Recordings

Dave's Waves—A Sonic Restaurant, ants CD 09 (2003).

Universary, Analysand A-KCS CD 9128 (2002).

The Good Book's (Accurate) Jail of Escape Dust Coordinates pt2, O.O. disc #23 (1996).

Resolver, O.O. disc #5 (1991).

Discography: Compilations

Apollo and Marsyas—Het Apollohuis 1980–1997, Apollo Records 090217 (2002).

The Alternative Schubertiade, CRI Emergency 809 (1999).

Armageddon, duet with William Hooker, Homestead Records HMS223-2 (1996).

New York Guitars, CRI Emergency 698 (1995).

KomunGuitar, duet with Jin Hi Kim, O.O. Disc #40, (1993).

Composer/guitarist David First has lived and worked in New York since 1984. Audio samples of the project discussed in this article can be found at <www.davidfirst.com>.